MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2018/2019

EEL2186 – CIRCUITS AND SIGNALS

(All Sections/Groups)

19 OCTOBER 2018
3.00 P.M. – 5.00 P.M.
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This Question paper consists of 6 pages including cover page with 5 Questions only.
2. Attempt **ALL FIVE** questions. The distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.
4. The Laplace Transform Pair and Properties tables are as given in Appendices A and B respectively for your reference.

Question 1

(a) State the three criteria for a tree in a network graph. [3 marks]

(b) State the difference between a mesh, a loop and a fundamental loop. [2 marks]

(c) For the given circuit below in **Figure Q1(c)**:

(i) Draw the corresponding oriented network graph. [2 marks]

(ii) Label branches with branch numbers and justify your number assignments. [2 marks]

(iii) Assuming anti-clockwise mesh direction, derive the mesh incidence matrix **B** (be sure to label your mesh number on the network graph). [4 marks]

(iv) Determine the branch impedance matrix **Z**, voltage source matrix **E** as well as the current source matrix **I**. [3 marks]

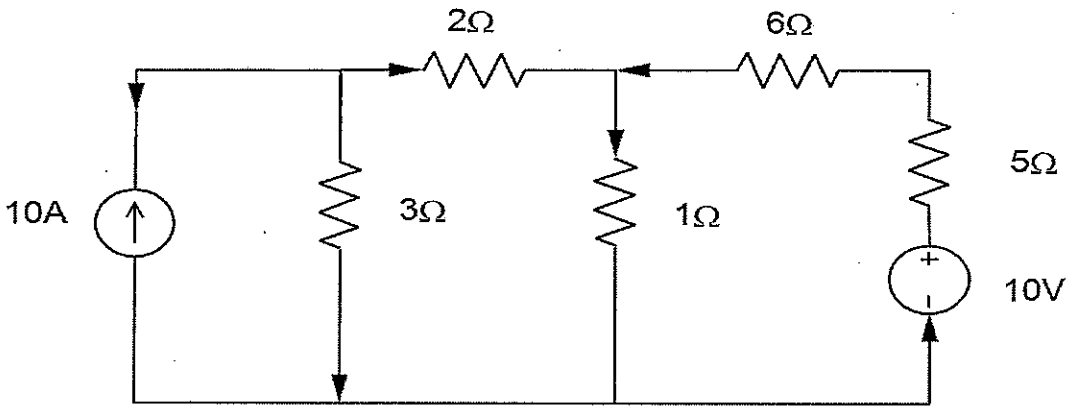

Figure Q1(c)

Question 2

(a) State whether the signal $f(t) = cos\left(t + \frac{\pi}{2}\right)$ is an even or odd function or neither. Justify your answer by finding the even and odd components. [4 marks]

(b) Determine if the signal $f(t) = 8u(t)$ is an energy or power signal. [5 marks]

(c) Two signals, $f_1[n]$ and $f_2[n]$ are as given below:

$$f_1[n] = e^{-n}u[n];$$
$$f_2[n] = u[n] + u[n-1] - 2u[n-4]$$

If $c[n]$ is the discrete convolution between $f_1[n]$ and $f_2[n]$, evaluate the convolution at $n = 4, c[4]$. [8 marks]

Continued...

Question 3

(a) It is given that:

$$F(s) = \frac{as^2+bs+2}{s^3+2s^2+s+1}$$

Use the initial value and time differentiation properties of Laplace Transform to determine the values of a and b such that $f(0) = f'(0) = 1$.

[8 marks]

(b) Determine the current, $i(t)$ for the circuit shown in **Figure Q3(b)** by applying Laplace Transform. Assume zero initial conditions. [9 marks]

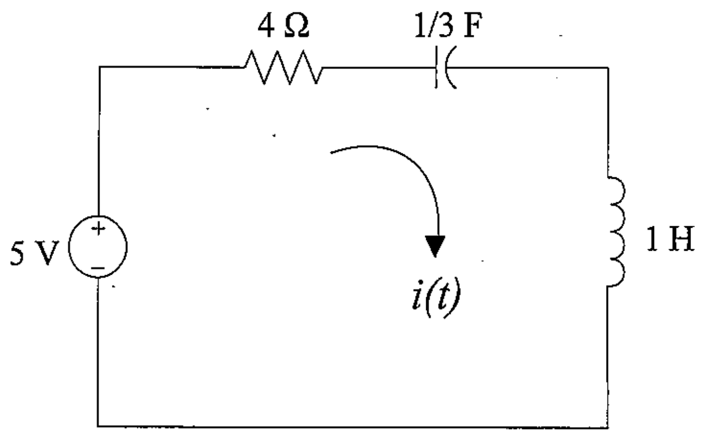

Figure Q3(b)

(c) The state-space representation of a system is given by:

$$\dot{\mathbf{x}} = \begin{bmatrix} 0 & 1 \\ -3 & -5 \end{bmatrix}\mathbf{x} + \begin{bmatrix} 0 \\ 1 \end{bmatrix}u,\ y = \begin{bmatrix} 0 & 1 \end{bmatrix}\mathbf{x}.$$

Determine the transfer function between the input, u and the output, y.

[8 marks]

Continued...

Question 4

The network shown in **Figure Q4** is a cascade of Network A and Network B. Find the transmission (ABCD) parameters for the cascaded network given that:

$$\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} A & B \\ C & D \end{bmatrix} \begin{bmatrix} V_2 \\ -I_2 \end{bmatrix}$$

[17 marks]

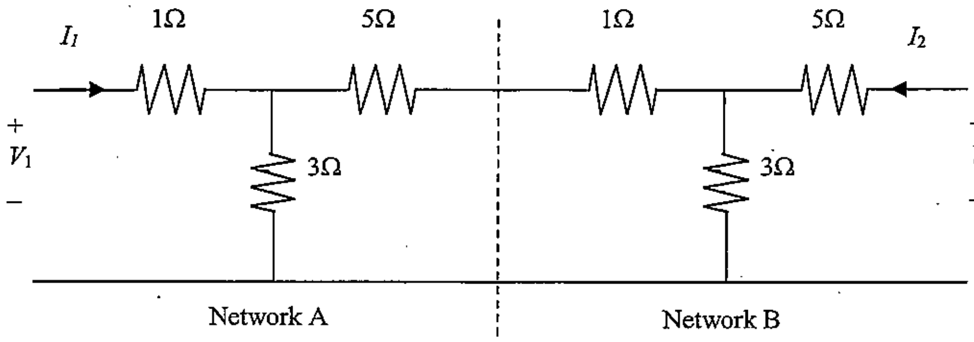

Figure Q4

Question 5

(a) Which of the following impedance functions can be realised as a resistor-capacitor (RC) network? Justify your answer.

$$F_1(s) = \frac{(s+2)(s+6)}{(s+1)(s+5)}\ ; \quad F_2(s) = \frac{(s+3)(s+4)}{(s+5)(s+6)}$$

[4 marks]

(b) Synthesise $Z(s) = \frac{s^4+5s^2+3}{s(s^2+2)}$ as an inductor-capacitor (LC) network using Cauer 1st form.

[9 marks]

(c) Find the order of a low pass (LP) filter by using Butterworth approximation procedure for the given specifications:
Maximum allowable pass band attenuation, $A_p = 4\ dB$
Maximum stop band attenuation, $A_S = 60\ dB$
Pass band limiting frequency = 8 MHz
Stop band edge frequency = 24 MHz

[4 marks]

(d) Find the transfer function of Butterworth filter when order of the filter, $n = 2$.

[8 marks]

Continued...

Appendix A: Table of Laplace Transform Pairs

No.	*t*-domain function	*s*-domain transform
1.	$\delta(t)$	1
2.	$u(t)$	$1/s$
3.	$tu(t)$	$1/s^2$
4.	t^n	$\frac{n!}{s^{n+1}}$
5.	e^{-kt}	$\frac{1}{s+k}$
6.	$t^n e^{-kt}$	$\frac{n!}{(s+k)^{n+1}}$
7.	$\sin \omega t$	$\frac{\omega}{s^2+\omega^2}$
8.	$\cos \omega t$	$\frac{s}{s^2+\omega^2}$
9.	$e^{-kt}\sin \omega t$	$\frac{\omega}{(s+k)^2+\omega^2}$
10.	$e^{-kt}\cos \omega t$	$\frac{s+k}{(s+k)^2+\omega^2}$
11.	$t\sin \omega t$	$\frac{2\omega s}{(s^2+\omega^2)^2}$
12.	$\sinh \beta t$	$\frac{\beta}{s^2-\beta^2}$
13.	$\cosh \beta t$	$\frac{s}{s^2-\beta^2}$
14.	$\sin(\omega t+\phi)$	$\frac{s\sin\phi+\omega\cos\phi}{s^2+\omega^2}$
15.	$2\lvert k\rvert e^{-\sigma t}\cos(\omega t-\varphi)$, where $k=\lvert k\rvert\angle\varphi$	$\frac{k}{s+\sigma+j\omega}+\frac{k^*}{s+\sigma-j\omega}$
16.	$f(t)$ periodic with period T	$\frac{1}{1-e^{-Ts}}\int_0^T f(t)e^{-st}dt$

Appendix B: Table of Laplace Transform Properties

Operations	$f(t)$	$F(s)$
1. Multiplication by scalar	$kf(t)$	$kF(s)$
2. Scaling	$f(kt),\ k\geq 0$	$\frac{1}{k}F\left(\frac{s}{k}\right)$
3. Addition and subtraction	$f_1(t) \pm f_2(t)$	$F_1(s) \pm F_2(s)$
4. Time shift	$f(t-t_o)u(t-t_o)$	$F(s)e^{-st_o}$
5. Frequency shift	$f(t)e^{\alpha t}$	$F(s-\alpha)$
6. Time differentiation	$\frac{df(t)}{dt}$	$sF(s) - f(0)$
	$\frac{d^2f(t)}{dt^2}$	$s^2F(s) - sf(0) - f'(0)$
7. Time integration	$\int_0^t f(\tau)d\tau$	$\frac{1}{s}F(s)$
8. Initial value	$\lim_{t\to 0} f(t)$	$\lim_{s\to\infty} sF(s)$
9. Final value	$\lim_{t\to\infty} f(t)$	$\lim_{s\to 0} sF(s)$
10. Frequency differentiation	$tf(t)$	$-\frac{dF(s)}{ds}$
11. Frequency integration	$\frac{f(t)}{t}$	$\int_s^\infty F(s)ds$
12. Convolution	$f_1(t) * f_2(t)$	$F_1(s)F_2(s)$

End of Paper.